Seven New Tomatoes

VARIETIES RESISTANT TO SPOTTED WILT FUSARIUM WILT, AND GRAY LEAF SPOT

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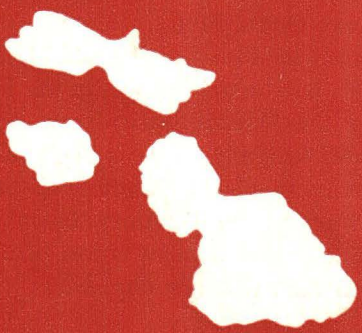

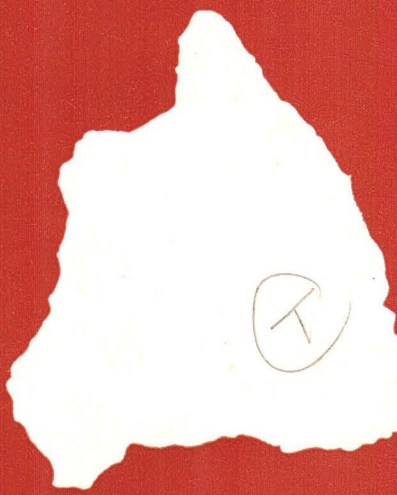

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FOREWORD

Seven new tomato varieties, each resistant to three destructive diseases—spotted wilt, fusarium wilt, and gray leaf spot—are described in this bulletin. It is fitting that these varieties have been named Hawaii, Kauai, Lanai, Oahu, Maui, Molokai, and Niihau, since farmers throughout the islands have cooperated wholeheartedly in the tomato improvement program conducted jointly by the Hawaii Agricultural Experiment Station and the Hawaii Agricultural Extension Service. The program is still under way and there is good reason to believe that in the years ahead better varieties, resistant to additional diseases, will become available to farmers of the Territory. Island names were assigned to the varieties at random so that adaptation of a variety to the island for which it has been named is not implied.

Seven New Tomatoes

VARIETIES RESISTANT TO SPOTTED WILT, FUSARIUM WILT, AND GRAY LEAF SPOT

by

W. A. FRAZIER, R. K. DENNETT, J. W. HENDRIX,
C. F. POOLE, AND J. C. GILBERT

OVER THE PAST SEVERAL YEARS the tomato has brought a higher total cash income to Hawaii's farmers than any other vegetable crop. Because of the popularity of the fruit of this crop among all racial groups, its adaptability to the Hawaiian climate, and the lack of serious competition with mainland imports during winter months, it was apparent some time ago that the tomato might well become a leading Hawaiian-grown vegetable. It was also recognized, however, that certain diseases were so destructive to common commercial varieties that an intensive breeding program would be required to develop high-yielding, disease-resistant types for local culture. Among the many disease enemies of the tomato in Hawaii, spotted wilt prevailed in every major tomato-growing area of the Islands (*6*), gray leaf spot was widespread in all low-elevation centers of production (*5*), and fusarium wilt was the cause of increasing concern to growers.

At the time of initiation of the breeding program, described in another report (*1*), it was not known how difficult it would be to locate resistance to these diseases or how difficult it would be to introduce and combine such resistance into commercial-type tomatoes. Consequently, it was deemed advisable to investigate resistance to the various diseases one at a time. Then as a final step it was planned that resistance to as many diseases as could be had should be combined in single varieties.

As the improvement program progressed, spotted wilt resistant Pearl Harbor was released (*6*) and the good probability of developing a gray leaf spot resistant variety was shown (*1*). In the meantime a source of resistance to fusarium wilt had been obtained in the variety Pan America (*8*) and, unknowingly, in certain lines used as parents in the gray leaf spot investigations. Crosses were made immediately between these lines and lines resistant to gray leaf spot and spotted wilt. Among the progeny of such hybrids were individual plants capable of resisting all three diseases (*2*). When this fact was realized the objective of this phase of the improvement program changed from developing varieties resistant to individual diseases to developing varieties resistant to all three diseases.

This bulletin describes seven varieties in which resistance to gray leaf spot, fusarium wilt, and spotted wilt is combined. Combination of resist-

ance to these three diseases solves three problems in one variety for the grower. Two of the diseases, spotted wilt and fusarium wilt, are extremely difficult to control in any practical manner other than by use of resistant varieties.

Resistance to several additional diseases is being sought as part of the over-all tomato improvement program. Satisfactory progress on two of these—mosaic (*4*) and root knot (*3*)—has recently been reported, but no commercial varieties are yet available. It is emphasized that the varieties Hawaii, Kauai, Lanai, Oahu, Maui, Molokai, and Niihau, described in the present publication, have been released for resistance *only* to spotted wilt, fusarium wilt, and gray leaf spot.

TABLE 1. Parentage of new tomato varieties.*

VARIETY	PARENTAGE
Oahu	[(PH-B × PH-Pr) × (B × PA-R)] × {[[(PH-B × PH-Pr) × ((MSF-L. peruv. × HG) × (GS-L. pimp.))] × BC-10-B] × PH-PA] × B × (PA-R)}
Lanai	{{[((MSF-L. peruv. × HG) × GS-L. pimp.) × BC-10-B] × PH-B × PH-Pr)} × {PH × [((MSF-L. peruv. × HG) × GS-L. pimp.) × PH-PA]}} × {PH × [((MSF-L. peruv. × HG) × GS-L. pimp.) × PH-PA] × PH × [((MSF-L. peruv. × HG) × GS-L. pimp.) × PH-PA]}
Hawaii	{[(MSF-L. peruv. × HG) × GS-L. pimp.) × BC-10-B] × (PH-B × PH-Pr)} × {{(Mo. Se. × PH) × [((MSF-L. peruv. × HG) × GS-L. pimp.) × BC-10-B)]} × PH-B × PH-Pr}
Maui	«{[((MSF-L. peruv. × HG) × GS-L. pimp.) × BC-10-B] × (PH-B × PH-Pr)} × {{(Mo. Se. × PH) × [((MSF-L. peruv. × HG) × GS-L. pimp.) × BC-10-B)]} × PH-B × PH-Pr}» × {(Mo. Se. × PH) × [((MSF-L. peruv. × HG) × GS-L. pimp.) × BC-10-B)]}
Molokai	Same as Maui
Kauai	Same as Oahu
Niihau	Same as Maui

* Key to abbreviations:

PH = Pearl Harbor; B = Bounty; Pr = Pritchard; PA = Pan America; R = Rutgers; MSF = Michigan State Forcing; L. peruv. = *Lycopersicon peruvianum;* HG = Home Garden; GS = German Sugar; L. pimp. = *L. pimpinellifolium;* Mo. Se. = line developed in Missouri by C. M. Tucker.

Several of the combinations used in the complex Hawaii hybrids were made elsewhere, as follows: B × PA-R, by W. S. Porte, U. S. Department of Agriculture; MSF-L. peruv. × HG, by A. F. Yeager, New Hampshire Agricultural Experiment Station; GS-L. pimp., by R. Urata, Hawaiian Sugar Planters' Association, Experiment Station; Mo. Se. × PH (numbered se.), by C. M. Tucker, Missouri Agricultural Experiment Station. The BC-10 tomato was furnished by M. W. Gardner, and originated from a cross made by D. R. Porter at the California Agricultural Experiment Station.

DEVELOPMENT OF NEW VARIETIES

PARENTAGE

In the period 1941–45, when the Pearl Harbor variety was under development, many crosses to improve fruit size and yield were made between

Pearl Harbor lines (then identified only by numbers) and commercial varieties. One of the most promising lines developed from the various combinations was from the double cross (Pearl Harbor × Bounty) × (Pearl Harbor × Pritchard). Further crosses between promising plants of this hybrid were made with lines of complex parentage carrying resistance to gray leaf spot and fusarium wilt. The final combinations of germ plasm were thus rather complex, as is shown in table 1. Because of the complexity of the crosses there is little point in speculating as to the contributions made by each parent in the synthetic varieties now being released. It is quite likely, however, that the resistance to spotted wilt was derived from Pearl Harbor (via BC-10), but perhaps also from German Sugar; the resistance to gray leaf spot was derived from *L. pimpinellifolium* (GS × L. pimp.); and resistance to fusarium wilt also from *L. pimpinellifolium* or from Pan America (*8*), which was derived from *L. pimpinellifolium*. Since BC-10 resistance to spotted wilt originated from *L. pimpinellifolium*, it appears likely that the species accounts for the three-way disease resistance in the new varieties. There is the possibility, however, that the *L. peruvianum* appearing in the parentage may have contributed genes for disease resistance also.

METHOD OF TESTING FOR THREE-WAY DISEASE RESISTANCE

After the crosses shown in table 1 were made, it was necessary to test several generations of progeny for disease resistance and desirability of horticultural characters. The timing and sequence used in testing for resistance to spotted wilt, fusarium wilt, and gray leaf spot were as follows:

1. From 50 to 100 seeds of each lot were placed in 1-gallon cans filled with sterilized soil. Bottoms of cans were perforated to allow good drainage.
2. Approximately 10 to 15 days after seeds were planted, a suspension of gray leaf spot spores was sprayed over the young seedlings with an atomizer.
3. Plants were left in a humidity chamber for approximately 48 hours.
4. Twenty-four to 72 hours after removal from the chamber, plants showing gray leaf spot lesions on the cotyledons were pulled up and discarded. This gave essentially a cotyledon test. Gray leaf spot spores were obtained either from infected plants growing in the field or were grown in the laboratory (*5*).
5. After removal of gray leaf spot susceptibles, plants were allowed to harden off 4 to 8 days, then were removed from the gallon cans, the roots dipped in fusarium inoculum (250 cc. of fusarium oat inoculum in 2,000 cc. of water), and the seedlings transplanted to 1-gallon cans or flats, where they were grown to transplant size.
6. If the weather was dry and hot, cans were kept in the shade 2 to 5 days to reduce losses from shock, after which they were set in the spotted wilt nursery (*6*).

7. Plants were left in the spotted wilt nursery 3 to 4 weeks for fusarium and spotted wilt to eliminate the susceptibles. Once each week cans were irrigated with a nutrient solution (3 to 4 pounds of 11-48 ammonium phosphate in 50 gallons of water). Plants with weak central stems, leggy growth, and sparse foliage were eliminated. Since plants were left in the cans long enough for the first and second blossom clusters to appear, late plants and those showing long styles, and small and/or rough fruits (from observation of ovary size and roughness) were also removed. If desired, indeterminate types were also removed. Thus, before plants were transplanted to the field, a relatively high percentage of the original population may have been eliminated.

TABLE 2. History of development of new tomato varieties resistant to spotted wilt, fusarium wilt, and gray leaf spot.

TEST NUMBER*	PLACE	DATE	TESTED FOR RESISTANCE TO†	NUMBER OF LINES TESTED	NUMBER OF PLANTS TESTED
C-1.....	University plots	Winter, 1944–45	Sm, TSW	7	64
C-2.....	University plots	Winter, 1944–45	Sm, TSW	10	200
C-3.....	University plots	Winter, 1944–45	Sm, TSW	17	576
C-4.....	Poamoho Farm and University Farm	Spring, 1945	Sm, TSW	16	110
C-5 & C-6	Poamoho Farm and Kipapa Farm	Summer, 1945	Sm, TSW	43	1,191
C-7.....	University Farm	Summer, 1945	Sm, Fus, TSW	26	1,030
C-8.....	Poamoho Farm	Fall, 1945	Sm, Fus, TSW	64	2,336
C-9.....	University Farm	Winter, 1945–46	Sm, Fus, TSW	10	419
C-10.....	University Farm	Winter, 1945–46	Sm, Fus, TSW	7	251
C-11.....	University Farm	Early Spring, 1946	Sm, Fus, TSW	3	293
C-12.....	Poamoho Farm	Early Spring, 1946	Sm, Fus, TSW	98	2,318
C-12K...	Kailua, HSPA	Early Spring, 1946	TSW	37	1,270
C-13.....	University Farm	Spring, 1946	Sm, Fus, TSW	3	44
C-14.....	University Farm	Spring, 1946	Sm, Fus, TSW	3	300
C-15.....	Poamoho Farm	Summer, 1946	Sm, Fus, TSW	41	2,005
C-16.....	Poamoho Farm	Summer, 1946	Sm, Fus, TSW	75	4,428
C-17.....	University Farm	Fall, 1946	Sm, Fus, TSW	36	1,774
C-18.....	University Farm	Fall, 1946	Sm, Fus, TSW	28	1,259
C-19.....	Poamoho Farm	Winter, 1946–47	Sm, Fus, TSW	180	11,598
C-20.....	Poamoho Farm	Spring, 1947	Sm, Fus, TSW	232	8,375
C-21.....	Poamoho Farm	Fall, 1947	Sm, Fus, TSW	133	4,722
C-22.....	Poamoho Farm	Early Spring, 1948	Sm, Fus, TSW	154	7,463
C-23.....	Poamoho Farm	Summer, 1948	Sm, Fus, TSW	122	7,172
C-24.....	Poamoho Farm	Winter, 1948–49	Fus, TSW	77	2,490
C-25.....	Poamoho Farm	Summer, 1949	Fus, TSW	24	3,583
Total plants tested for disease resistance.....					65,271

* In addition to the plantings listed here, which served as the principal means of introducing genes for disease resistance, over 100 cooperative tests with farmers have been conducted on farms throughout the Territory. These tests have been made possible through the cooperation of Extension specialists and county agricultural agents.

† Sm = gray leaf spot; TSW = spotted wilt; Fus = fusarium wilt.

8. Remaining plants were transplanted either to tile beds or to the field.

The various plantings which have been made for carefully supervised experimental tests are shown in table 2. These plantings served as the principal means for testing progeny of individual plant selections for degree of resistance to diseases, as well as for desired vine and fruit characters. In addition, from 1946 through 1949, numerous tests were run on farms throughout the Territory in cooperation with Extension Service specialists and county agricultural agents.

DEGREE OF DISEASE RESISTANCE OF NEW VARIETIES

All the new varieties possess excellent resistance to gray leaf spot. Their resistance to fusarium wilt is believed to be, in general, as good as that possessed by Pan America, with the possible exception of Oahu and Maui, and far superior to the resistance or tolerance often exhibited by Rutgers. Resistance to the form of spotted wilt thus far present in Hawaii is excellent and is apparently on a level equal to that of Pearl Harbor. Data obtained in a recent test on resistance to the three diseases are shown in table 3. The data show clearly the high resistance to gray leaf spot and fusarium wilt. Spotted wilt data, because of low incidence of the disease, are less satisfactory, yet the data are indicative of results

TABLE 3. Resistance of tomato varieties to three diseases.

VARIETY	GRAY LEAF SPOT		FUSARIUM WILT*		SPOTTED WILT†			
					Nursery		Field	
	Plants tested	Percent susceptible	Plants tested	Percent susceptible	Plants tested	Percent infected	Plants tested	Percent infected
Oahu	114	0	175	14.3	175	0	31	0
Lanai	124	0	245	1.2	245	0	51	0
Hawaii	124	0	199	5.0	199	0	44	0
Maui	182	0	194	17.0	194	0	45	0
Molokai	182	0	198	5.6	198	0	92	0
Kauai	114	0	295	3.7	295	0	120	0
Niihau	182	0	198	3.5	198	0	61	0
Bounty	58	100	20	100.0	100	5.0	45	12.0
Pearl Hrbr.	77	100	20	100.0	50	0	30	0
Rutgers	66	100	18	100.0	20	5.0	18	6.0
Bay State ..	...	...	20	100.0	...	..	...	...
Pritchard ..	75	100	16	100.0	...	..	...	...
Pearson	...	...	...	....	37	3.0	...	...

* Soil temperatures of 72 to 90° F.; air temperatures of 70 to 80° F. Susceptibles include plants killed as seedlings or apparently stunted. Stems of plants apparently stunted were cut to determine whether there was vascular discoloration. All plants showing vascular discoloration were included as susceptible. Relatively few plants of the new varieties were killed by the fungus, whereas a high percentage of the plants of check (susceptible) varieties was killed or severely stunted.

† See text for notes on other tests.

obtained in earlier tests. The incidence of spotted wilt in tests C-20, 21, 22, and 23, for check varieties, was 53.3, 19.6, 10.5, and 5.0 percent, for example, whereas all plants of Lanai, Hawaii, Maui, Molokai, Kauai, and Niihau were free of spotted wilt. The variety which showed the most recent susceptibility to spotted wilt was Oahu, which, for the above listed tests, showed 26.7, 5.0, 5.0, and 0 percent infection. Thus Oahu has had a relatively recent record of spotted wilt susceptibility and, though it has been free of the disease in the last two tests, it should be watched closely for possible further segregation.

BRIEF VARIETY CHARACTERIZATION

The varieties Oahu, Molokai, and Kauai have rather distinctive growth habits. Hawaii, Maui, Lanai, and Niihau are somewhat similar in appearance in the field.

OAHU

(Previously tested as numbers 2680, 3576, and 4301.)

Stocky tomato of Bounty type, with ability to set fruit well at low elevations in summer. Lacks vigor when grown under low temperature conditions. Requires relatively high soil fertility for maximum production.

Early; determinate; short vine; medium open; fruits moderately exposed to sun; immature fruit color a uniform, very light green, even ripening.

Ripe fruits medium to large; globular. Stem end scar medium to large; stylar scar medium to large. Slightly to moderately rough. Medium to many locules. Outer and inner walls medium in thickness. Inner and outer color scarlet.

Medium radial cracks; slight to severe puffiness, depending upon conditions under which grown.

Resistance to gray leaf spot excellent; to fusarium wilt, fair to good; to spotted wilt, apparently good, yet requires further observation.

This distinctly early tomato does not possess high market quality, but is being released for its excellent adaptability to low elevation areas during the warmest period of the year.

LANAI

(Previously tested as numbers 3207, 3549, and 4308.)

Semi-sprawling tomato with medium to good vigor.

Medium early; determinate; vines rather open, elongated; immature fruit color a uniform, very light green.

Ripe fruits medium large to large; globular to deep globular. Stem end scar medium; stylar scar medium. Generally smooth. Medium locule number. Outer walls medium to thick; inner walls medium. Inner and outer color scarlet. Possibly more susceptible to blotchy ripening than most varieties.

Radial cracking slight; concentric cracking medium to severe under conditions favorable to cracking.

Resistance to gray leaf spot, fusarium wilt, and spotted wilt excellent.

Well adapted to low elevations in winter, to medium elevations at all seasons, to high elevations in summer. Should be given uniform moisture supply and kept well fertilized to provide good foliage cover, thereby reducing losses from concentric cracking.

HAWAII

(Previously tested as numbers 3208, 3559, and 4310.)

Rather open vine, sprawling, with medium to good vigor.

Medium early; determinate; vine elongated; immature fruit color a uniform, very light green.

Ripe fruits medium to medium large; deep globular. Stem end scar medium to small; stylar scar medium to small. Fruits smooth. Locule number medium. Outer walls medium in thickness; inner walls medium. Inner and outer color scarlet. Some blotchy ripening.

Radial cracking slight; concentric cracking severe under conditions favorable to cracking.

Resistance to gray leaf spot, fusarium wilt, and spotted wilt excellent.

Well adapted to low elevations in winter, to medium elevations at all seasons, to high elevations in summer. Should be fertilized and irrigated well to provide good foliage cover.

MAUI

(Previously tested as numbers 3628 and 4211.)

Medium open vine; vigor medium to good.

Medium early; determinate; sprawling; vine elongated; immature fruit color a uniform, very light green.

Ripe fruits medium large to large; globular. Stem end scar medium; stylar scar medium. Fruits generally smooth, occasionally rough. Locule number medium. Outer walls medium to thick; inner walls medium. Inner and outer color scarlet. Some blotchy ripening.

Radial cracking slight; concentric cracking medium to severe under conditions favorable to cracking. Puffiness generally not present.

Resistance to gray leaf spot and spotted wilt excellent; resistance to fusarium wilt fair to good.

Well adapted to low elevations in winter, to medium elevations at all seasons, to high elevations in summer.

MOLOKAI

(Previously tested as numbers 3205 and 4312.)

Semi-stocky type vine, with medium vigor.

Medium early; slightly open, with rather large leaves; immature fruit color a uniform, very light green.

Ripe fruits medium to large; globular to deep globular. Stem end scar medium to large; stylar scar medium to large. Most fruits smooth. Medium locule number. Outer walls medium to thick; inner walls medium. Inner and outer color scarlet.

Slight radial cracking; concentric cracking medium to severe under conditions favorable to cracking. Puffiness sometimes medium to severe.

Resistance to gray leaf spot excellent; to fusarium wilt good; to spotted wilt excellent.

Well adapted to low elevations in winter, to medium elevations at all seasons, to high elevations in summer. This variety is still variable for tendency to puff; recent selections have been made on basis of freedom from this defect. Puffiness may be especially severe during cloudy, rainy weather, especially under conditions conducive to rapid growth.

KAUAI

(Previously tested as numbers 3575 and 4313.)

Indeterminate, yet rather stocky vine, with thick stems and semi-upright growth habit; medium to good vigor. Better adapted to staking and pruning than other varieties being released at this time.

Medium early; medium open; immature fruit color a uniform, very light green.

Ripe fruits medium large to large, with late fruits tending to maintain sizes well; globular to deep globular. Stem end scar medium to large; stylar scar medium to large. Fruits generally smooth, with occasional rough fruit. Medium to large number of locules. Outer wall medium thin; inner walls medium to thick, with better than average inner solidity. Inner and outer color scarlet.

Medium radial cracking; concentric cracking slight to medium under conditions conducive to cracking.

Resistance to gray leaf spot, fusarium wilt, and spotted wilt excellent.

Well adapted to low and medium elevations throughout the year, to high elevations in summer.

NIIHAU

(Previously tested as numbers 3231 and 4314.)

Semi-sprawling vine type, with medium to good vigor.

Medium maturity; determinate; vines somewhat open; immature fruit color a uniform, very light green.

Ripe fruits large; globular to slightly flattened. Stem end scar medium to large; stylar scar medium to large. Fruits slightly to moderately rough, with more tendency to roughness than other varieties being released at this time. Medium to many locules. Outer walls medium thick; inner walls also medium. Inner and outer color scarlet.

Radial cracking slight; concentric cracking medium to severe under conditions favorable to cracking.

Resistance to gray leaf spot, fusarium wilt, and spotted wilt excellent. Well adapted to low elevations in winter, to medium elevations at all seasons, to high elevations in summer. Released for better than average fruit size and slightly better than average vigor as compared to other three-way resistant lines. Should be selected further for smoother fruit type.

PRODUCTIVITY AND GENERAL ADAPTABILITY

When grown at elevations for which recommendations have been made under "Brief Variety Characterization" all the varieties described are capable of producing heavy yields of fruit. This assumes, of course, that good cultural practices are followed. The varieties are earlier and more productive under warm temperature conditions than any other known disease-resistant commercial types available to growers in Hawaii.

Results of a replicated yield test, conducted at Poamoho Experimental Farm on Oahu, are shown in table 4. Pearl Harbor in this test, where fusarium wilt and gray leaf spot were not destructive, gave a relatively high yield, but not significantly higher than for the varieties Lanai, Maui, and Niihau. The distinctly early variety, Oahu, gave a low yield, primarily because of low vigor in this test. The variety Kauai, the only indeterminate in the group, was handicapped relatively more than were the determinates by a heavy infestation of leaf miners late in the season.

Yields in a late spring test on the island of Maui are shown in table 5. While the varieties were not replicated, it is of interest that the four highest yielding varieties were Niihau, Lanai, Maui, and Kauai. Low yield from Pearl Harbor in this test appeared to be due primarily to small fruit size. Numerous other tests during recent years, made by farmers throughout the Islands in cooperation with the Agricultural Extension Service, have demonstrated the high yielding ability of the new varieties. In fields in which soil has been heavily infested with the fusarium wilt fungus, Pearl Harbor has produced very low yields compared to the new varieties.

While the new varieties in general do not set fruit as heavily as Pearl Harbor, they have the advantage of larger fruit size in addition to resistance to fusarium wilt and gray leaf spot.

In cool wet weather at high elevations in winter, the varieties are not so well adapted, being highly susceptible to early and late blights and lower in vigor than Rutgers. The possibility of use of the new varieties in F_1 hybrids at high elevations is now under study. The resistance to spotted wilt, fusarium wilt, and gray leaf spot is dominant, so that, in F_1 hybrids with vigorous types more tolerant to early and late blight, resistance to the diseases is maintained, in addition to greater vigor and yielding ability.

Since all the varieties except Kauai are distinct determinates, the conventional type of pruning and staking should not be practiced. It is highly desirable, however, particularly during rainy weather of winter, to keep the plants off the soil by means of heavy mulches or a framework

of some type over which vines may trail. Use of fungicides to control early blight, late blight, septoria, and possibly other diseases is required, particularly in winter, in all areas.

TABLE 4. Tomato yields at Poamoho Experimental Farm, summer 1949.*

VARIETY	YIELD IN TONS PER ACRE		
	Grade 1	Grade 2 and culls	Total
Oahu	7.4	3.3	10.7
Lanai	14.2	2.1	16.3
Hawaii	11.7	2.8	14.5
Maui	14.5	2.2	16.7
Molokai	13.0	2.1	15.1
Kauai	8.2	1.8	10.0
Niihau	13.6	2.0	15.6
Pearl Harbor	16.0	3.0	19.0
Least significant difference at .05% probability between average yields of grade 1	2.9	...	...

* Seed planted June 7, 1949; planted in field July 15; harvested 9/12, 9/19, 9/22, 9/26, 9/29, 10/3, 10/6, 10/12, and 10/19.

TABLE 5. Tomato yields in farmers' cooperative test. S. Nihei farm, Omaopio, Maui. Single-row plots. Spring and summer, 1949.*
Elevation 1,300 feet.

VARIETY	YIELD IN TONS PER ACRE		RESISTANT TO
	Marketable†	Total†	
Niihau	22.09	23.19	Spotted wilt, fusarium wilt, gray leaf spot
Lanai	20.60	21.55	Spotted wilt, fusarium wilt, gray leaf spot
Maui	19.51	20.36	Spotted wilt, fusarium wilt, gray leaf spot
Kauai	16.13	16.97	Spotted wilt, fusarium wilt, gray leaf spot
Step 89 (3794)‡	15.02	16.04	Fusarium wilt, collar rot
Step 87 (3796)	13.22	13.64	Fusarium wilt, collar rot, late blight
Step 90 (3793)	12.60	13.20	Fusarium wilt, collar rot
Step 88 (3792)	10.67	11.65	Fusarium wilt, collar rot, late blight
Pritchard (3548)	10.54	11.06	.....
Rutgers (3992)	10.46	12.38	.....
Pearl Harbor (3544)§	9.93	11.45	Spotted wilt
Step 94 (3788)	9.91	10.85	Collar rot, late blight
Step 82 (3786)	9.77	10.27	Fusarium wilt

* Seed planted January 6, 1949.

† Based on yields from healthy plants, and calculated from average yields per plant. Approximately 20 plants in the test for each variety. None replicated.

‡ Step lines refer to tomatoes from other sources, originating in the Southern Tomato Exchange Program trials conducted cooperatively by several states. Step numbers 87, 88, 89, 90, and 94 were developed by C. F. Andrus at the U.S.D.A. Vegetable Breeding Laboratory, Charleston; Step 82 was developed by C. M. Tucker, Missouri Agricultural Experiment Station.

§ Fruits averaged too small.

ACKNOWLEDGMENTS

The cooperation of many individuals has made possible the tomato improvement program in Hawaii. K. Kikuta, J. S. McFarlane, S. Tachibana, and M. Matsuura of the Hawaii Agricultural Experiment Station aided materially in many phases of the work; specialists of the Agricultural Extension Service, J. H. Boyd, Robert Burton, and A. M. Hieronymus, and county agricultural agents took an active part in placing cooperative trials with farmers throughout the Islands. The authors are indebted to several individuals outside the University of Hawaii for tomato lines used in the hybridization program: W. S. Porte, C. F. Andrus, C. M. Tucker, A. F. Yeager, R. Urata, A. Mangelsdorf, M. W. Gardner, and Paul G. Smith. We are deeply grateful to the many farmers who have run cooperative tests and have aided in estimates of the values of the new varieties.

SEED OF NEW TOMATO VARIETIES

The Hawaii Agricultural Experiment Station will maintain a small supply of stock seed of the new varieties. This will be available in small lots to farmers or seedsmen who wish to test them or to increase seed. The Station cannot, however, make available large commercial quantities of the seed.

Address requests for seed to :

Hawaii Agricultural Experiment Station
University of Hawaii
Honolulu 14, Hawaii

or

Agricultural Extension Service
University of Hawaii
Honolulu 14, Hawaii

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FIG. 1. At 10 to 15 days of age, plants are sprayed with a suspension of gray leaf spot spores. The container is then placed in a humidity chamber for 48 to 72 hours, so that spores will germinate.

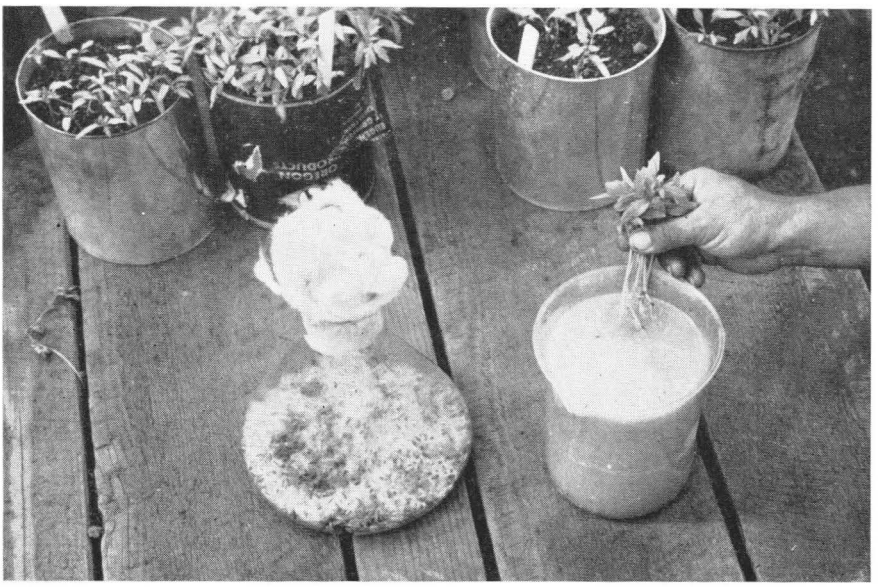

FIG. 2. After gray leaf spot susceptible plants are eliminated, seedlings are removed from the containers, the soil is washed off, and roots are dipped in fusarium inoculum. Flask on left shows fusarium fungus growing on oats. Inoculum shown in beaker on right is prepared by macerating the oat culture, after addition of water, in a Waring Blendor.

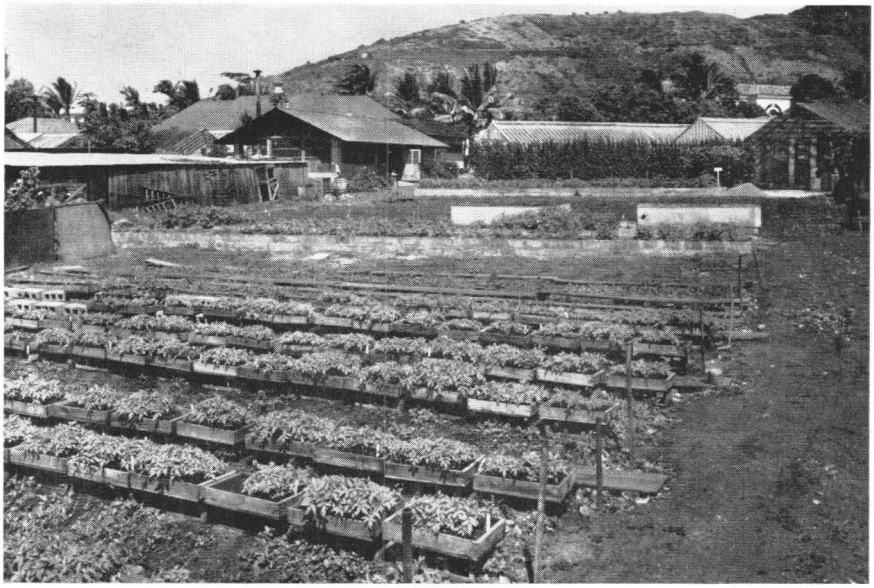

FIG. 3. Spotted wilt nursery. After seedlings have been dipped in fusarium inoculum, they are transplanted to flats or cans and placed in this area. For the nursery, a weed, *Emilia sonchifolia*, is grown, and onion thrips are transferred to the *Emilia* from onions to facilitate transfer of the disease to tomato seedlings. It is known that onion thrips are vectors for the virus.

FIG. 4. In this area seedling tests for resistance to gray leaf spot, fusarium wilt, and spotted wilt have been carried out. On lower right is the humidity chamber used for gray leaf spot tests.

FIG. 5. After seedling tests for fusarium wilt, gray leaf spot, and spotted wilt are completed, the remaining resistant plants are transplanted to field plots for observation of many horticultural characters.

FIG. 6. Sectioning of fruit is necessary to determine internal quality factors, such as color, number of locules, and thickness of walls of interlocular septae and outer ovary wall.

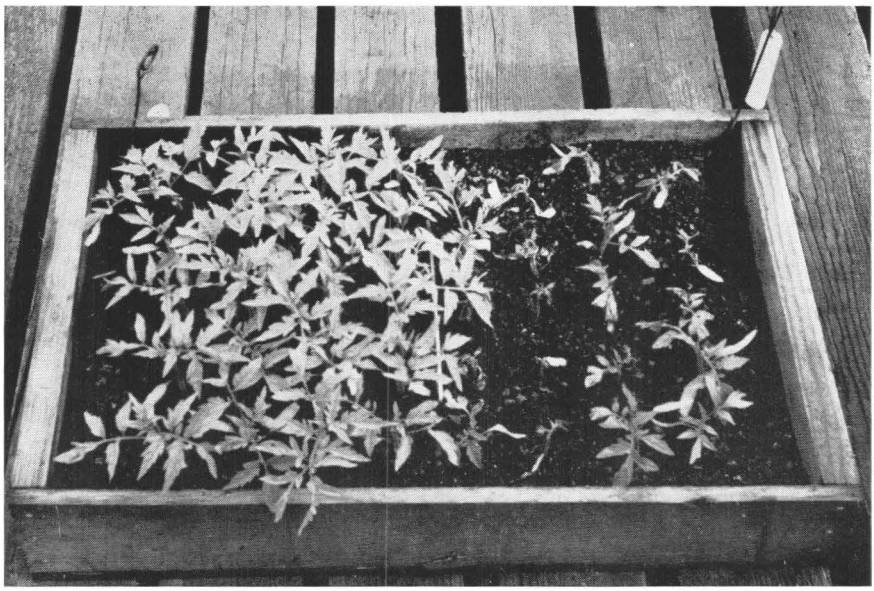

FIG. 7. Tomato seedlings 11 days after inoculation with fusarium wilt. On left, highly resistant plants of Hawaii; on right, susceptible variety Bounty.

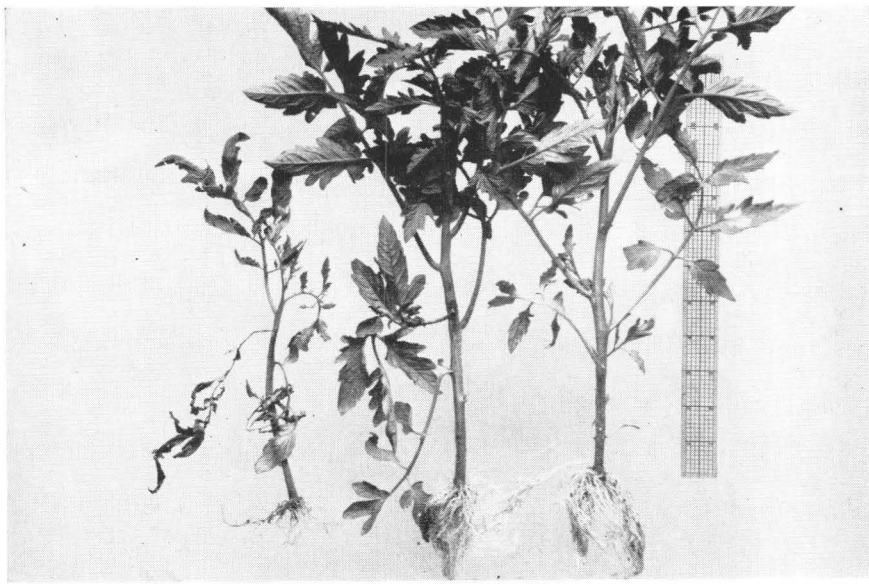

FIG. 8. Susceptible plant on left systemically infected with spotted wilt virus; plant in center shows spotted wilt infection of second leaf on left, with tissues of petiole affected, as well as moderate streaking of stem. This type of infection is occasionally found in seedlings of the resistant varieties discussed in this bulletin. The resistance is therefore a resistance to systemic infection. Healthy plant on right.

FIG. 9. Vine of Molokai. Seeds planted June 7. Photographed August 26.

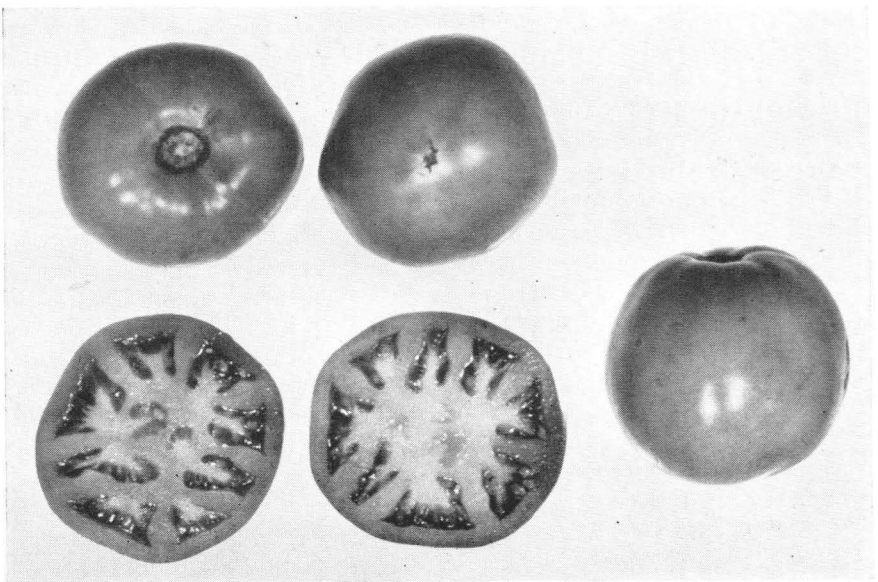

FIG. 10. Fruit of Molokai variety.

FIG. 11. Vine of Oahu. Seeds planted June 7. Photographed August 26. Note early fruit set and small, stocky Bounty-type vine.

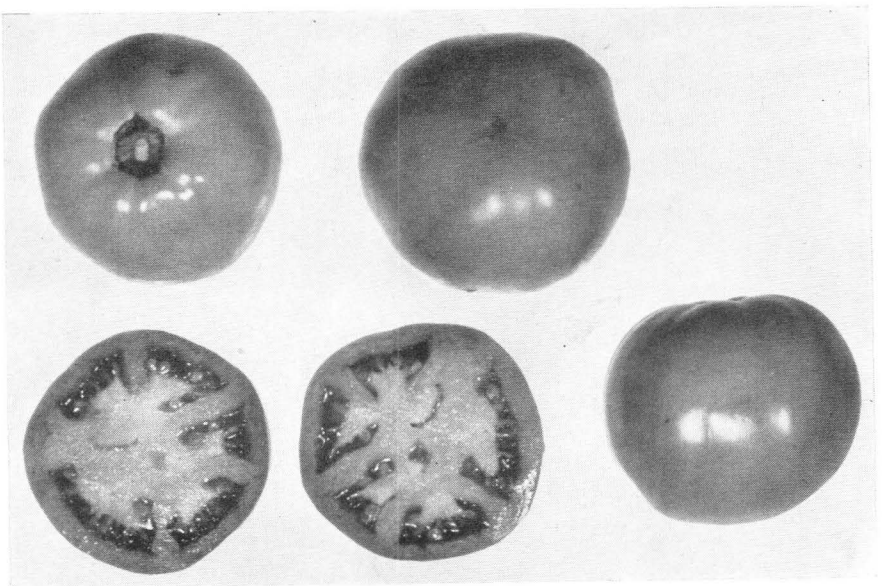

FIG. 12. Fruit of Oahu variety.

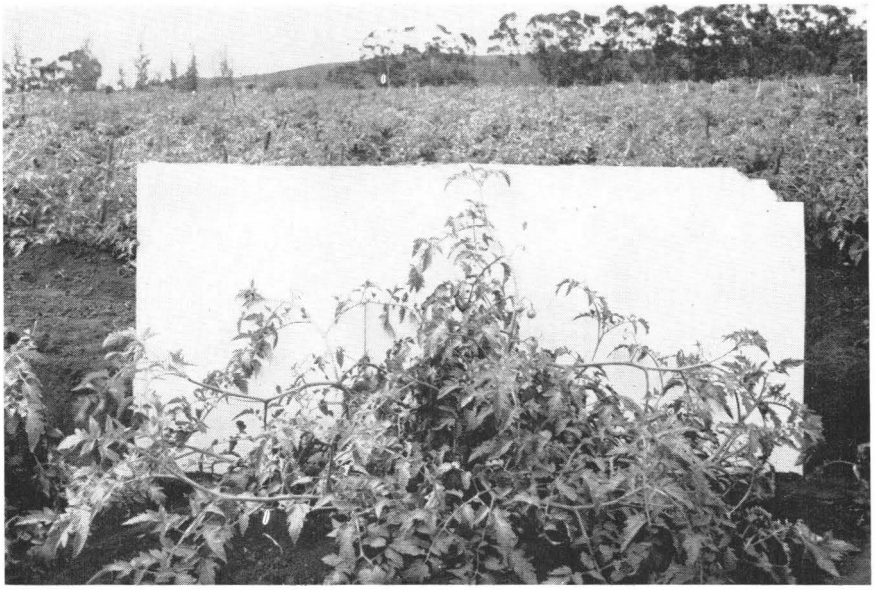

FIG. 13. Vine of Lanai. Seeds planted June 7. Photographed August 26. Note sprawling, rather open vine characteristic. Varieties Hawaii, Maui, and Niihau are somewhat similar in appearance.

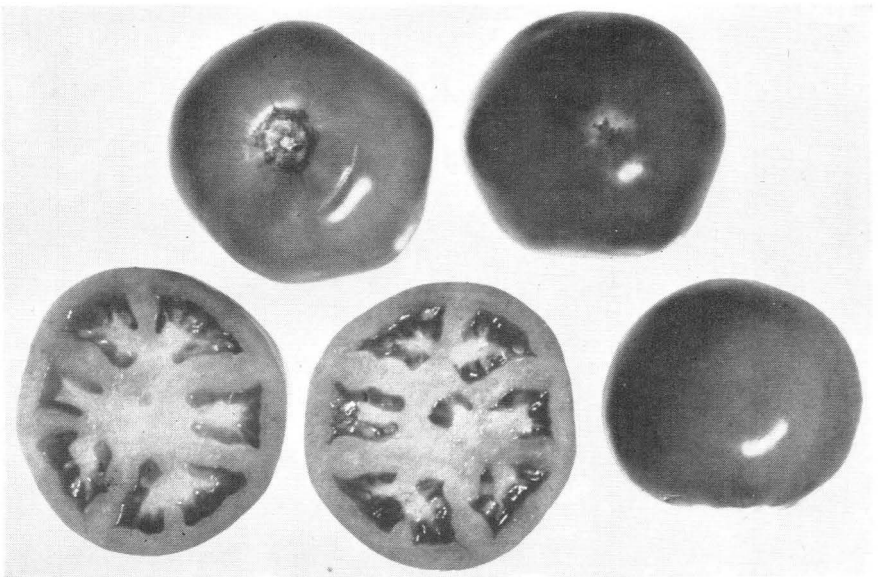

FIG. 14. Fruit of Lanai variety.

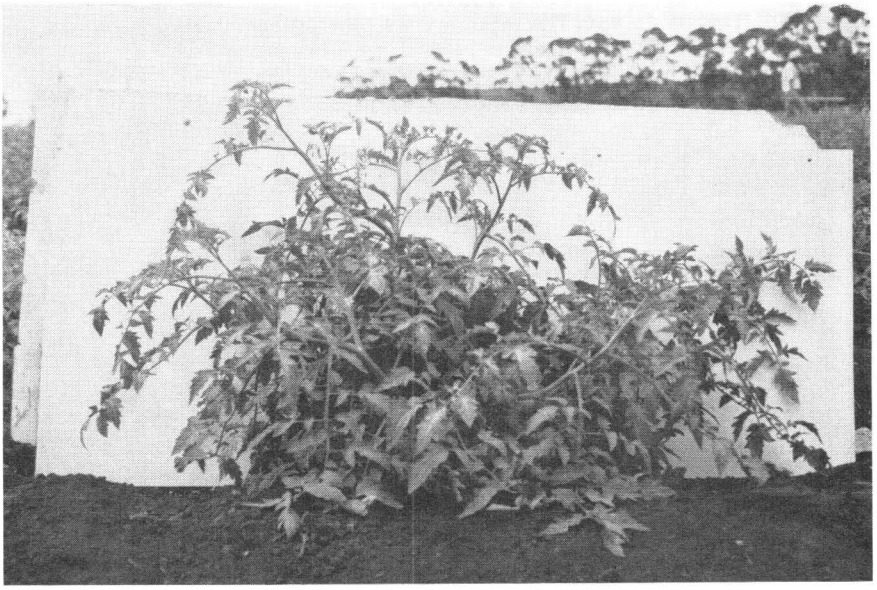

FIG. 15. Vine of Kauai. Seeds planted June 7. Photographed August 26. Upright, heavy stem, indeterminate, becoming medium open and sprawling as fruits mature.

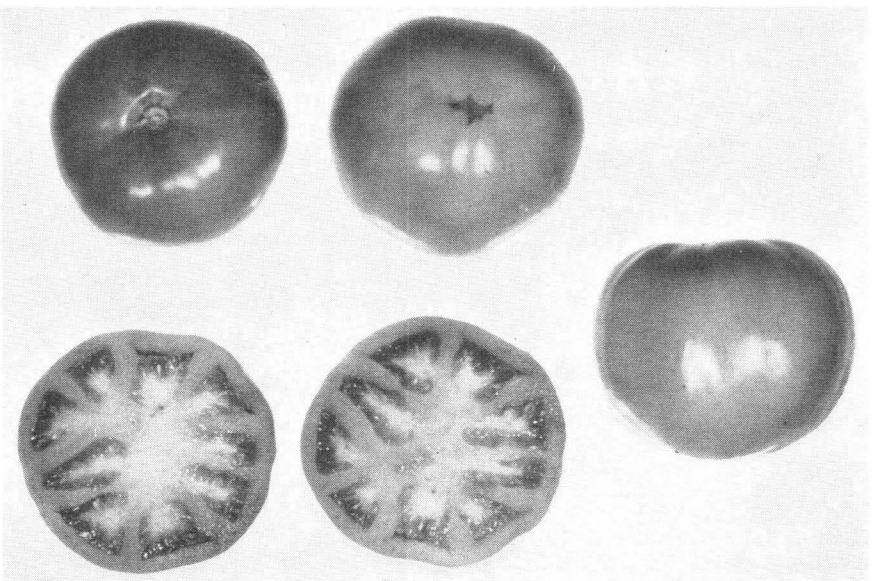

FIG. 16. Fruit of Kauai variety. Note medium large stylar scar.